DOCUMENT RESUME

ED 440 844 SE 063 415

AUTHOR	Cozzens, Margaret B.
TITLE	Instructional Materials Development (IMD): A Review of the IMD Program, Past, Present, and Future.
INSTITUTION	National Science Foundation, Arlington, VA. Directorate for Education and Human Resources.
PUB DATE	2000-05-00
NOTE	14p.
AVAILABLE FROM	For full text: http://teech.terc.edu/papers/papars/cozzens.htm.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Educational Resources; Elementary Secondary Education; *Instructional Material Evaluation; *Material Development; Mathematics Education; Program Descriptions; Science Education

ABSTRACT

Instructional materials influence what students are taught and how teachers teach. An innovative, comprehensive, and diverse portfolio of instructional materials that implement standards-based reform in mathematics, the natural and social sciences, and technology education is required for preK-12+ education. This paper discusses the history of the Instructional Materials Development (IMD) program--including development, dissemination, adoption, and implementation--and provides a glimpse into the future of the program. (CCM)

◀ back to list of Papers

Instructional Materials Development (IMD)
A Review Of The IMD Program, Past, Present, And Future
National Science Foundation
Education And Human Resources Directorate
Elementary Secondary And Informal Education Division

written by Margaret B. Cozzens, Division Director

This paper provides the supporting text for the Instructional Materials Development Review that took place at NSF in March of 1996

Contents

Current and Future Plans Across IMD: Develop, Evaluate, Disseminate and Implement, and Measure Impact

Background

Introduction

Instructional materials influence what students are taught and how teachers teach. An innovative, comprehensive, and diverse portfolio of instructional materials which implement standards-based reform in mathematics, the natural and social sciences, and technology education is required for preK-12+ education. These materials must be of high quality and consistent with state and national standards, to be widely adopted and used in schools nationally. They must provide students with the skills, knowledge, and attitudes necessary to function in a high performance workplace and to continue their education. High quality materials that are accurate in content, age-appropriate, and accessible to all students are essential to raising levels of student achievement, and are one of the major building blocks of systemic reform. The development of a wide range of quality instructional materials is fundamental, but so too, is the dissemination, adoption, and implementation of these materials.

The curriculum and materials development of the Sputnik Era in the late 50's and 60's was both a response to competition with the Russians and what we had learned from researchers like Howard Gardner and Jerome Bruner about how young minds grow and the knowledge about how that growth can be stimulated through the use of new methods and materials. This era saw the birth of "hands-on" science. The politics and the culture of the time, however, dampened this effort in the 50's and 60's to introduce real change into classrooms across the country. Also, these materials were designed on the premise that children can know and do much more than we thought they could, but these materials were predominantly used in a tracking environment and only reached the top 20% of students. However, in both mathematics and science they paved the way for the new materials of today by addressing age-specific needs and individual learning styles. We also learned from these earlier prototypes that their success is highly dependent on the professional development of all teachers, not just a self-selected group of teachers with excellent mathematics and science backgrounds who were interested in using innovative materials. It also became abundantly clear that not everyone wanted to teach children how to think independently. This issue still remains today!

The NSF/Federal Role in Materials Development

The Instructional Materials Development Program (IMD) at the National Science Foundation (NSF) supports the development of strategies and materials that promote the improvement of science, mathematics, and technology instruction for students at all ability levels. As an agency that has a broad mandate to support the vitality of basic science, engineering, and mathematics in the United States, NSF develops materials broadly and comprehensively across the mathematics, science, and technology education disciplines, and the grade level continuum. According to the *Federal Coordinating Council for Science, Engineering and Technology (FCCSET) FY1994 Budget Summary* , NSF spent $43.9 million of the total federal expenditure of $54.3 million for curriculum improvement. This broad mandate makes NSF unique among federal agencies engaging in science, mathematics, and technology education activities. In FY1994, only four other Federal agencies were engaged in the development of instructional materials in these areas. The National Aeronautics and Space Administration (NASA) was second in expenditure with $4.4 million, followed by the Environmental Protection Agency (EPA) with an expenditure of $3 million, the Department of Energy (DOE) with $2.2 million, and the Department of Health and Human Services (NIH), with $.8 million. See Appendix A. Each of the mission agencies (NASA, Energy, EPA, and NIH) develops short modules in disciplines that advance the mission of the agency.

IMD Goals

The IMD goal is to develop instructional materials, aligned with standards for content, teaching and assessment, that:

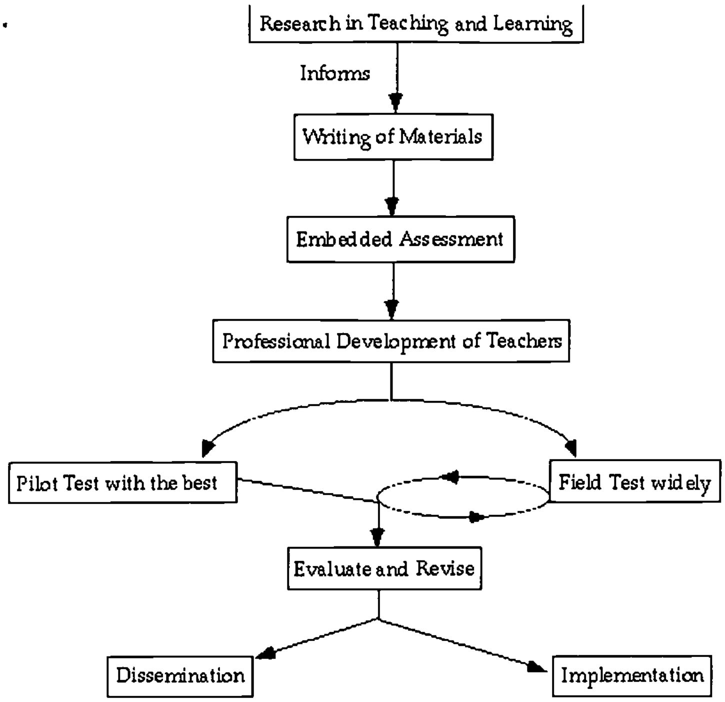
- enhance the knowledge, thinking skills, and problem-solving abilities of all students;
- apply the latest research on teaching and learning;
- are content accurate and age-appropriate;
- incorporate the recent advances in disciplinary content and educational technologies;
- assist teachers in changing practices; and
- ensure implementation in broadly diverse settings.

IMD Processes

The development of instructional materials in science, mathematics, and technology education is a complex process. Guiding principles frame the processes for the development of NSF sponsored materials. The materials:

- are developed by a collaborative of scientists, mathematicians, teachers, and educators;
- are based on research in teaching and learning;
- align with standards;
- contain appropriate student assessment;
- are field tested in diverse settings; and
- have undergone formative and summative evaluation, which include impact data from field test sites.

Components of this process can be best understood through the following diagram:



Mathematics Instructional Materials Development

In 1989, the teachers of mathematics in this country through the National Council of Teachers of Mathematics (NCTM) released the *Curriculum and Evaluation Standards for School Mathematics* . The NCTM Standards built a framework for what children should know and be able to do at various grade levels of school mathematics. They were a culmination of a grass roots effort by teachers who knew well from experience that the mathematics being taught in classrooms across the country was not working, and it was inadequate in meeting the needs of students, higher education, and the workplace. The membership of NCTM knew that the Standards, however, needed more than written documents. The country needed new instructional materials to deliver the Standards, existence proofs to show that the Standards are indeed attainable, and teachers to implement them on the front line.

With the advent of the Standards, the National Science Foundation (NSF) saw the need for providing leadership in the development of new mathematics materials, if the US had any hope of being first in the world in mathematics achievement for all students. The NCTM Standards provided not only a framework for the development of new materials, but they also brought visibility and an eager constituency for high quality innovative instructional materials. Therefore, in 1989, NSF launched a series of initiatives to fund the development of mathematics materials grades K-5, eighteen months later the development of grades 6-8 materials, and finally in 1993 the development of grades 9-12 materials. Believing that schools and school systems needed a choice of quality materials, a number of curriculum development projects at each of these three levels was funded. Since curriculum materials development is a complex and costly undertaking, each project was funded for five years to complete the development of multiple years of comprehensive materials. In addition, two high school mathematics projects actually began work earlier than the rest with initial funding from other sources and consequently completed development before the rest.

Each of the projects shared the following characteristics:

- a belief that it was possible to significantly improve the teaching mathematics over what was currently available;
- the materials were to reach as many students as possible;
- the use of the technology of calculators and computers;
- the need to involve students more actively in their own learning;
- that applications of mathematics should be incorporated into the mainstream of experiences of students in classes; and the sharp barriers between algebra, geometry, or any other branch of mathematics, should be blurred.

Despite these similarities which defined their strengths, the curriculum materials offer unique choices for teachers to use in their own classrooms.

.The development of new mathematics instructional materials was not easy, particularly when the NCTM Standards called for a paradigm shift in the way teachers would use these materials. These are comprehensive materials, not disjoint units of mathematics, so the development of concepts over time and grade levels is essential and was closely monitored in the pilot and field testing. At the same time the materials were evaluated, the ability of teachers to use these materials was also evaluated. Both student achievement and teacher achievement were measured. Ongoing professional development for the pilot and field test teachers was essential if the materials were to have a fair test and for the developers to gain maximum feedback. Assessment of student learning was built into the materials. Once the materials were field tested they were revised again, sometimes retested, and then submitted to publishers for publication. At this point the developers thought they would be done, but they found out otherwise. Now, those who eagerly awaited the new materials, put even more pressure on the developers and the publishers to get preprint copies of the materials and professional development opportunities to implement the materials. See Appendix B1 for a graph of the development of comprehensive mathematics curriculum materials.

By the end of 1997, the elementary and middle school mathematics curriculum materials and at least grades 9 and 10 secondary mathematics materials will be published and readily available for use in schools across the nation. By the end of 1998 all of the secondary materials will be published. A description of these materials is included in Appendix B2.

Science Instructional Materials Development

Science For All Americans was published in 1989 by Project 2061 of the American Association for the Advancement of Science (AAAS), and contains a set of recommendations on what understandings and habits of mind are essential for all citizens in a scientifically literate society. It began the movement towards science standards (even though it dealt with mathematics, social sciences, and technology as well as science), that would eventually describe what children should know and be able to do in the sciences. Project 2061, in their own words, attempted to establish a conceptual base for reform by defining the knowledge, skills, and attitudes all students should acquire as a consequence of their total school experience, from kindergarten through high school. *Benchmarks for Science Literacy* , published by AAAS in 1993, describes how students should progress toward science literacy, recommending what they should know and be able to do by the time they reach certain grade levels. Building on both *Science for All Americans* and the development of *Benchmarks for Science Literacy* which was underway at the time, the National Research Council of the National Academy of Sciences brought together diverse groups of scientists, engineers, teachers, and science educators in 1992 began the development of the *National Science Education Standards* . The *National Science Education Standards* , published in December 1995, go beyond the other documents and includes not only content standards, but standards for science teaching, for professional development for teachers of science, for assessment, for science education programs, and for science education systems.

Unlike in mathematics, NSF's renewed involvement in the development of instructional materials in science predates issuance of the standards. Starting in 1986, with what were called the *TRIAD* projects, the NSF IMD program began an extensive process to fund the development of instructional materials for science in elementary schools. Prior to that time, very little science was taught in elementary schools in the nation. In the belief that quality instructional materials would motivate teachers to teach more science and teach science using an inquiry, hands-on approach, NSF began to make a major investment in the development of science materials for school use. Two years later the *TRIAD* projects were extended to the development of middle school science instructional materials. The *TRIAD* projects were characterized by development teams of scientists, materials developers, school people, and publishers, under the belief that the materials would have a better chance of dissemination if the publishers and school people were brought in at the outset.

Unfortunately, it was too easy for publishers to withdraw support at points along the way, and some projects were never published. However, the *TRIAD* experiment did give birth to a number of exemplary elementary science projects, for example the *Full Option Science Series* (FOSS) published by the Encyclopedia Britannica, and *Insights* , originally published by Optical Data, soon to be transferred to Kendall Hunt. Since early 1992 during the end of the development phase of these projects, the projects were advised to keep close track of the development of the AAAS *Benchmarks for Science Literacy* and *Science for all Americans* . The innovation and quality of these elementary projects set the stage for NRC *National Science Standards* at the elementary level. Thus, there is considerable alignment of the materials with the Standards. In addition, a number of the developers of the *TRIAD* science materials were participants in the development of the Standards.

As the field began to recognize the need for hands-on science materials at all grade levels, developers also began the development of new innovative secondary science instructional materials. The first of these new materials was developed starting in 1986 by the American Chemical Society, called *Chemistry in the Community (Chem-Com)* . *Chem-Com* is designed to focus on the study of chemical concepts that emphasize chemistry's impact on society.

Chem-Com is designed to teach students about the important role that chemistry plays in their personal and professional lives, how to use knowledge of chemistry to think through and make informed decisions about issues involving science and technology, and the need to develop a lifelong awareness of both the potential and limitations of science and technology. Data indicate that these materials benefit all students, including those intending to major in the sciences in college.

Recently, the success of *Chem-Com* has motivated the development of comparable materials for physics (*Active Physics*), biology (*Bio-Com*), and earth science (*Earth-Com*). In addition, there will soon be the publication of a number of comprehensive materials for secondary science, none of which are fully integrated across all scientific disciplines.

Appendix C gives a graph of the development of science instructional materials.

Middle School Science Study

In an attempt to begin to more fully determine the status of instructional materials for science, now that the *Science Standards* are published, ESIE began a study of instructional materials for middle school science in March 1996. NSF started with middle school science materials because much was already known about the elementary science materials developed through the TRIAD projects and elsewhere. The middle school study provides a review of past and current NSF-supported efforts, and identifies areas where more development is necessary. A portion of the middle school study provides brief reviews of noncomprehensive materials, both where NSF has supported the development and otherwise. Preliminary findings from this in-depth study are now available and a public document will be disseminated in late 1996. The main goals of the study were to answer the following questions:

- What are the characteristics of NSF-supported instructional materials for middle school science?
- How sufficiently do extant materials provide for a comprehensive program for middle school science consistent with national standards for science education?

The study emphasized a review of comprehensive curricula, those that equal a year or more of course material. Secondarily, the study reviewed modules or units that can serve as building blocks for a comprehensive program. The central criteria for reviewing the instructional materials were as follows:

- Is the science content correct?
- How well designed are the materials to provide for conceptual growth in science?
- How well do the materials align with the Science Standards?

Current and Future Plans across IMD - Develop, Evaluate, Disseminate and Implement, and Measure Impact

The mission of the Instructional Materials Development Program (IMD) is to develop, evaluate, disseminate, and implement science, mathematics, and technology education instructional materials, and to measure their impact on students and teachers.

Develop - Current and Future

Currently projects are supported in all areas to develop (including pilot and field testing) comprehensive instructional materials in mathematics, science, and technology education. In addition projects are supported that integrate mathematics, science, and technology education in the curriculum in schools. For example, the *Integrated Mathematics, Science, and Technology Project* (*IMAST*), is developing integrated materials for 7th and 8th grade students around the topics of biotechnology, manufacturing, forecasting, energy transformation, transportation, and others. The materials are designed to be taught by teachers from all three disciplines for at least 120 minutes per day. Although there are separate activities for mathematics, science, and technology, the activities focus on the same key concepts and are coordinated so the students readily see the relationships among the disciplines.

Comprehensive projects often develop a year's worth of materials at a time and then look to completing a sequence useable for multiple years. For example, *Chemical Education for Public Understanding (CEPUP)* , instructional materials were developed in the early 90's for middle school science students. Two years later, *Science Education for Public Understanding (SEPUP)* , expanded the number of CEPUP units to include units in all of the physical sciences and earth science. Under the name, *Issues, Evidence and You* , these units were developed on local issues for middle school students and on global issues for high school students. The development of *SEPUP* materials contained embedded assessment materials, encouraging the developers to decide early in the development what skills and content the students should learn. NSF has recently funded *Life Science Education for Public Understanding* , to complete the series to a full comprehensive set of instructional science materials for grades 6-10 which cover life, physical, and earth sciences.

It is not always the case that the development of new materials is necessarily required to meet the demand for standards-based up-to-date materials. In some instances, it may be more effective to revise and/or expand existing materials. For example, the popular National Geographic *Kids Network* consists of technology-based materials that allow students to communicate with other students around the world and to collect and analyze scientific data through a nationwide electronic network (e.g. acid rain). The original materials were designed for students in grades 4-6. The project has now been expanded for students in grades 7-9. A second example is the *Middle School Mathematics Through Applications-Computers and Design (MMAP)* , a project that was designed to provide technology-based mathematics units for middle school students. At the time *MMAP* was funded in the early nineties, it was not clear that enough schools would have computer equipment available for students all day long. However, the demand for the *MMAP* materials has been so great in both urban and suburban settings, that an extension of *MMAP* to a comprehensive complete set of mathematics instructional materials for grades 6-8 was funded in 1995.

The advent of new technologies and their availability in schools has created a need for more educational materials that are technology-based. This phenomenon is what led to the expansion of *MMAP* and the *Kids Network* materials expansions. Recently other projects have been funded to increase the set of quality technology-based materials, such as the *Mapping your City - Geographic Informations Systems (MCGIS)* . The *MCGIS* materials engage students in use of the GIS database system to correlate complicated datasets on variables such as green space, income, census figures, and ethnicity so they can map their local communities.

Early childhood researchers have been telling the public over the last few years that young children learn much more readily if the teaching methods meet their special needs, that acceleration of standard curriculum to earlier years is not only unproductive but potentially dangerous. The most important ingredients in young children's education is hands-on learning, physical activity, and socialization. Even though the need for hands-on materials in mathematics and science is widely recognized, there are very few instructional materials available for children ages 3 through 5, yet increasing numbers of children are in some kind of school setting during those years. The development of hands-on early childhood mathematics and science instructional materials is a high priority for IMD in the next few years.

Coupled with the need to provide materials for early childhood education is the recognition that instructional materials must be available for parents and other care-givers. A special solicitation that crosses all program areas in the ESIE Division calls for projects that will provide help for parents and care-givers to support their children's science and mathematics endeavors at home and elsewhere, and encourage them to be effective advocates for more universally available quality mathematics and science education. The IMD portion of this solicitation is for projects that develop instructional materials for parents.

Instructional materials are needed that will radically change instructional practices and student learning. Particular examples include (a) involving students in research experiences that teach skills related to the scientific process - hypothesis development, data analysis, presentation of results (e.g. providing and understanding geographically distributed data, or data retrieved from large image sets); (b) use of advanced instructional technologies to change what can be learned by collaborations of students and teachers; (c) the teaching of the processes of "design under constraint" and or modeling in the context of science, mathematics, and technology education; (d) use of authentic workplace situations that promote learning of disciplinary content, workplace competencies, and career awareness. Such materials must be able to engage students with different learning styles in the study of technical subjects and must provide explicit guidance for teachers as they change their teaching practice.

Increasingly, projects are needed that span the grade levels from 10 through 14. For example, there are many students taking college algebra in colleges or universities, and many students taking calculus in high school. Instructional materials are needed at all these levels that are standards-based and that encourage hands-on activities and the student as an active learner. Many more students take advanced placement science courses in high school today than previously, yet they go on to college and take courses that have no relationship to what they had in high school. Articulation of materials - secondary and undergraduate-is paramount and a responsibility of IMD in ESIE and the Course and Curriculum Development programs in the Undergraduate Division.

Evaluate - Current and Future

Evaluation of instructional materials during their development is essential. Various paradigms for insuring proper evaluation of materials developed with NSF funding before publication have been in place since early 1993 and will continue to be used in the monitoring process. For example, the developers of the comprehensive mathematics instructional materials projects have met as a group with NSF staff once a year at a Gateways Conference. Each of the developers has brought the current version of their materials to Gateways to be critiqued by their fellow developers and the NSF staff. Gateways provides an opportunity for the developers to share their problems, issues, and successes with one another. The Gateways Conference in October 1995 hosted a Public Forum at which time students, teachers, administrators, and others gave public testimony to the success of these materials at the field test sites. The University of Chicago then published the document, *The Success of Standards-based Mathematics Curricula for all Students, a Preliminary Report (see endnote 1.)* .

All instructional materials development projects are required to have an external advisory board consisting of scientists, mathematicians, and educators. In addition, because of the limitations on staff travel, some program officers add an external *auditor* to the project. It is the responsibility of the external *auditor* to review all materials at each draft and report back to NSF any problems he/she encounters. The external *auditor* also visits schools where field testing is taking place in order to understand the effectiveness of the materials in classrooms. Often, the second and third year continuation funding for a project is not made until the materials have been reviewed by an external panel of reviewers appointed by the program officer. In addition, the third year funding for a project is not granted unless the project has signed a contract with a publisher to publish the materials. As much as possible, with limited travel funds, program officers make site visits to the development projects and their field test schools.

The Research, Evaluation, and Communication Division is currently performing a programmatic evaluation of the Instructional Materials Development Program. Key aspects to be considered are the dissemination capability of IMD and the quality of materials through random reviews. The tentative completion date for the IMD program review is late 1997.

The Middle School Science Study was designed to provide the staff at NSF, and in turn the field, with a broad understanding of the instructional materials in middle school science, their quality, and their match with the *National Science Standards* . The instrument used to conduct the study was developed by Mark St. John of Inverness Associates to review a specific set of middle school instructional materials. The review panel modified the Inverness instrument, tested it on one set of materials, and then reviewed twenty other sets of materials. The revised instrument is now available to the public to help them choose quality materials for use in schools (see endnote 2). Each of the sets of middle school science materials rated by the reviewers had been or is currently being developed with NSF funding and is comprehensive in nature. A third party review of middle school science instructional materials that are either not comprehensive or were not funded by NSF will be completed in late 1996.

For the future, the IMD program will continue to use external *auditors* , review panels, and others to review draft instructional materials developed with NSF funding prior to publication to assess accuracy and usability of the materials. In addition, meetings similar to Gateways meetings will be initiated for science developers. The first such meeting will take place in late 1996 and bring together all of the current developers of high school science comprehensive materials. After that meeting, NSF may conduct a high school science study similar to the one conducted for middle school science materials. During FY 1997 NSF will experiment with the use of reverse site visits for all large IMD projects at the midpoint of their grant cycle.

Disseminate and Implement - Current and Future

Dissemination of instructional materials and information related to these materials is an ever increasing aspect of the work of IMD. In 1993, IMD believed that an electronic database of all instructional materials developed through NSF funding was one solution to the problem of getting usable information out to the field. The NIRL database was created as a searchable database, and one that included developer, publisher, evaluative, and summary information on each project. The database was put on line through the world-wide web, and included a toll free 800 number for more information. NIRL was somewhat successful at getting information about the products quickly to teachers, but without substantial advertising, its potential impact was muted. Updating the database became an impossibly expensive problem, both for developers, NSF, and the contractor. Consequently, the database are to be brought in-house to NSF, and a system of updates will be undertaken by NSF staff and the grantees through an on-line system. Once the updates are completed and a user-friendly system is established, the database will be advertised and made available over the world-wide-web. Meanwhile the Clearinghouse in Ohio sponsored by the Department of Education serves as a repository for NSF funded materials, as well.

Much of the task of dissemination of the new instructional materials falls on the shoulders of the publishers themselves. The publishers clearly want to see the materials used and they market them through the standard mechanisms at meetings, by telephone calls, with visits, etc. Since the use of these materials requires additional professional development and a cost effective way of reaching large numbers of teachers, NSF has launched two local systemic change initiatives, one in K-8 mathematics and science, and one 7-12 for mathematics. These initiatives are district-based teacher enhancement projects and assume that the districts have either chosen the materials they will use, or will do so during the first year of the award and part of the enhancement is then designed around the selection of new materials. Substantial evaluation paradigms, managed by an outside contractor, were built into the local systemic change project initiatives from the outset. These processes are designed to evaluate changes in teacher practice and effectiveness of instruction, and include an analysis of the use of instructional materials, The local systemic evaluation model is being adapted for use in other systemic initiatives, and in Eisenhower professional development projects. In addition, one component of the yearly accountability portfolio submitted to NSF by the rural, city, and state systemic initiative projects includes the use of quality instructional materials at their site. All of these activities provide mechanisms for the dissemination of high quality materials, including those developed with IMD support.

The current dissemination strategies will continue and additional information will be provided to the technical assistance contractors and those managing teacher preparation activities. A number of short monographs describing the new standards-based instructional materials in mathematics, science, and technology in sufficient detail to facilitate choice by schools have been developed, are in production at this time, or will be drafted (see endnote 3).

Implementation of quality instructional materials is an ongoing challenge. Since early 1996, the NSF IMD and Teacher Enhancement Programs (TE) have encouraged submission of implementation proposals. These implementation projects can cover a variety of tasks, from the development of videos of classroom usage of sets of the new materials, to guidebooks on how to make good choices of materials, to how to gain parent and community support for the materials, to articulation across grade levels and/or disciplines. The staff hoped that leaving the descriptions open-ended would result in a number of interesting implementation grants. However, in the first round only one award was made. The FY1997 guidelines are more descriptive and suggestive.

Some of the issues surrounding dissemination and implementation will be discussed in the next and last section of this paper.

Measure Impact - Current and Future

It becomes increasingly clear that NSF must be able to validate claims that students are learning more science, mathematics, and technology, including problem solving, critical thinking, and basic skills, through the use of these new standards-based instructional materials. To help us evaluate these claims, projects are now required to provide student achievement data from their field test sites and this data must include information from diverse populations. Continuations and new awards are made contingent on the quality and availability of this data. Often, NSF staff visit classrooms to directly assess effectiveness of the materials as well.

IMD has undertaken a few targeted longitudinal studies to measure the impact of the new standards-based instructional mathematics materials on student achievement for a period of up to ten years, during the last years of the project's development and for the first few years that the materials are commercially available, post the end of the grant. One example is Norm Webb's extensive evaluation of the *Interactive Mathematics Project* secondary materials in six implementation sites across the country. Included in this evaluation is a transcript study that tracks students through the four years of high school and into college.

In addition, The *mosaic of evidence study* is being developed by the RAND Corporation to measure the impact of systemic reform on student achievement in ten systemic initiative sites, each of which is using the new mathematics and science instructional materials. It is hoped that this study will also contribute to an evaluation of the use of the materials. Two impact studies were completed in 1993 (Webb and Reynolds) which measured the impact of nine mathematics and ten science sets of instructional materials (see endnote 4).

IMD staff are continually looking for new, cost effective ways of measuring the impact of its instructional materials projects on students and teachers.

Issues for Instructional Materials Development Implementation

The motivation for developing innovative, standards-based instructional materials is to improve the teaching and learning of science, mathematics, and technology. But the development is only the first step and will not contribute significantly to improvements in teaching and learning unless the materials are used widely by teachers prepared to use them effectively and who have the understanding and support of school administrators, parents, and others in the community.

The NCTM Standards for Mathematics and the NRC Standards for Science point to a dramatic departure, in content and pedagogy, from the traditional approach to teaching and learning in mathematics and science. Several serious issues are inherent in the implementation of any standards-based instructional materials:

- Standards-based instructional materials require a significant amount of professional development for teachers in both content and pedagogy;
- Publishers are not prepared to provide the needed teacher support activities and often don't realize they need more than they did with traditional texts;
- The textbook adoption process is an expensive process that some smaller publishers of innovative materials are not prepared to undertake, yet the process pays big dividends for those who do, for example Encyclopedia Brittanica with FOSS;
- Implementation requires support and buy-in from administrators, parents and the community, and when the support is missing from one group, as initially happened in Palo Alto CA and Ames IA, the whole reform movement can be in jeopardy;
- Assessment of student learning must be linked to the instructional materials, and the design of new assessment tools has not kept up with the development of new materials and the standards;
- Articulation across grade levels and disciplines is essential; and
- Teacher preparation in colleges and universities must be linked with the new materials to facilitate implementation, yet most college and university departments are unaware of either the Standards or the new materials.

Until we address these salient issues as a program, and as a directorate, implementation of new innovative materials will be limited.

Publishers and Publishing

Publishing instructional materials in mathematics and science is not only necessary for dissemination and use, but since 1986 has been a requirement of all awards made by NSF for development of materials. Inherent difficulties often occur at the outset with securing publishers, but many issues arise after contracts have been signed and the materials are published. Among the issues resident in publishing the materials are the following:

- Many publishers have competing materials that they market and may provide only minimal marketing for the new materials;
- Many small publishers and even some large ones are being bought out by large publishing houses, so that eventually there may be only 3 or 4 companies publishing instructional materials;
- Many of the new materials contain substantial teacher materials and very little student materials making it hard for the publishers to make money in their present form;
- Many of the new materials consist of kits, supplies, videos, not normally produced by textbook publishers;
- Many concerns exist about the intellectual property rights for publishers whose materials are placed on the Internet either by them or others.
- Internet materials simply are out there, with no indication of quality or use.

The issues of technology and choice of materials, and the publisher's role in the solutions to problems in these areas are enumerated in the next pages.

Materials Selection at Local and State Level

Implementation of quality instructional materials, and the dissemination of NSF developed instructional materials often come together at the site where the selection of school materials takes place. Administrators, teachers, and stakeholders at the state and local levels are forced to make very costly and extremely critical decisions regarding what instructional materials will best serve their students. When faced with the wide array of instructional materials available on the open market, they often become caught in a storm. Spin doctors, money managers, and fast-talking sales people with little understanding of the issues, are part of the fracas in which decision makers find themselves. Issues for NSF include the following:

- Should NSF fund what might be called a *seal of approval* for instructional materials, those developed through NSF funds and/or those not, together with a published *consumer reports* listing those that earned the seal, possibly with ratings of the materials?
- Is it possible to create a guide for school systems to use in selecting materials? This might include evaluative instruments similar to the instrument used for the middle school science study.
- How can parents and other lay persons, who often participate in curriculum materials selection, be convinced that all students can be educated, while maintaining excellence? What materials should be developed to help groups make better decisions regarding materials?

All of the above issues revolve around getting maximum information concerning instructional materials to a variety of audiences, and at the same time protecting NSF from being accused of mandating specific materials, particularly in their funded systemic sites.

Information Technologies

Educational technologies are changing rapidly. Many, but not all, school systems now have access to many new delivery venues that make possible today what was thought to be science fiction a few years ago. With the rapid, continuous changes taking place in schools and in technology development houses, IMD is faced with an array of issues:

- Should developers design software for state-of-the-art hardware systems or for what is available today for use in schools?
- Should we encourage all IMD projects to include information technologies or leave it to the specialists?
- Is there sufficient research to know how to effectively use educational technologies in classrooms?
- Since it will require massive teacher enhancement to prepare teachers to use both the new hardware systems and the new software available for them, and once a teacher is so trained, in a few years the technology will change once again, how do we build a professional development system for teacher technology education?
- Is it possible to ensure equal access and use of information technologies for all students? It is apparent that poor schools and rich schools have the best chance at providing the technologies, in the first case through donations, in the latter case they can afford it.
- Are parents, students, business and industry personnel, who expect the use of technology in schools, willing to make the sacrifices necessary to assure quality materials and use?

Summary

Since its inception in 1950, the National Science Foundation has served the Nation by investing in research and education in science, mathematics, and engineering. Over the years NSF's investments in education have included investments in the development of instructional materials for use in classrooms across the country, preK-12. NSF believes, and rightly so, that education reform and improved student achievement cannot be accomplished without quality instructional materials in use in classrooms. The IMD program has helped to assure the use of quality materials through development, evaluation, dissemination, and implementation activities. These activities will continue and intensify in response to increased calls for improvement through standards-based materials. Data suggests that the materials recently developed and field tested in diverse settings by diverse teachers are making a difference in student achievement, particularly in mathematics.

IMD will continue to develop standards-based quality materials for use by all students and all teachers across the nation. Particular emphasis in the next few years will be placed on completing the portfolio of science materials, expanding the portfolio of early childhood mathematics and science materials, and revising and expanding the materials that incorporate the use of learning technologies in effective ways. Implementation of the materials developed with NSF funding, especially in mathematics, will be increasingly important and receive a considerably amount of attention. Effective ways to measure impact, in particular that students are learning more mathematics, science, and technology, will be sought and used. Materials by themselves, if not used effectively by teachers to improve student achievement, have no value. Therefore it is essential that we determine how teachers can use the quality materials most effectively to support their students' learning.

As NSF becomes more accountable for its actions, so, too, will the developers and implementers of the portfolio of mathematics, science, and technology materials to be used in the 21st century.

Endnotes

1. The Success of Standards-Based Mathematics Curricula for All Students - A Preliminary Report, Gateways IV Public Forum on the Impact of Mathematics Education Reform, University of Chicago, Chicago, Illinois, October 1995, available from NSF.

2. Middle School Science Study Instrument, available from NSF by contacting any IMD program officer.

3. Technology Education Instructional Materials, Elementary- High School, Instructional Materials Development, Division of Elementary, Secondary, and Informal Education, National Science Foundation, NSF 96-61, February 1996.

4a. Impact Study of 10 NSF-Supported Pre-College Science Instructional Materials Projects, W.W. Reynolds, I

Gawley, F. Pregger, Reynolds & Schaeffer Associates, Inc., October 1993.

4b. Dissemination of Nine Precollege Mathematics Instructional Materials Projects funded by the National Science Foundation, 1981-91, N. Webb, H Shoen, and S. Whitehurst, Wisconsin Center for Education Research, Madison Wisconsin, April 1993.

Appendix A

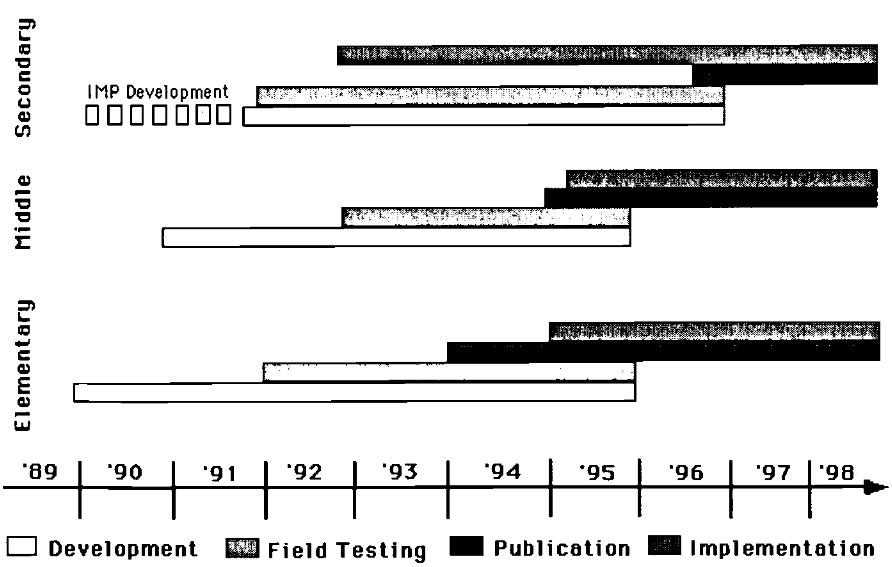
Current Agencies Involved in Curriculum Improvement

Agency	94 Budget* (millions)
National Science Foundation Fostering state-of-the-art mathematics and science	43.9
National Aeronautics and Space Administration Fostering Space Science	4.4
Environmental Protection Agency Fostering Environmental Education	3.0
Department of Energy Programs Associated with Laboratories	2.2
Department of Health and Human Services NIH - Fostering Health Education	.8
Department of Education	0
Department of Interior	0
Department of Defense	0
Department of Agriculture	0

* FCCSET FY1994 Budget Summary

Appendix B1

Comprehensive Mathematics Curricula



Appendix B2

Funded Projects with Contact Information

ARISE: Applications/Reform in Secondary Education (H)
Landy Godbold 404-355-8673

Connected Geometry (H)
E. Paul Goldenberg 617-969-7100x2513

The Connected Mathematics Project (M)
Kathy Burgis 517-432-3635

Cooperative Mathematics Project (E)
Laurel Robertson 510-533-0213x247

Core-Plus Mathematics Project (H)
Christian R. Hirsch 616-387-4526

IMP: Interactive Mathematics Program (H)
Diana Resek 415-338-2071

Investigations in Number, Data and Space (E)
Susan Jo Russell 617-547-0430

Math Connections, A Secondary Mathematics Core Curriculum Project (H)
June G. Ellis 203-244-1942

Mathematics in Context: A Connected Curriculum for Grade 5-8 (M)
Thomas Romberg 608-263-4285

Middle School Mathematics Through Applications Project (M)
Shelley Goldman 415-497-7963

Seeing and Thinking Mathematically (M)
Glen Kleinman 617-969-7100

SIMMS: Systemic Initiatives for Montana Mathematics and Science (H)
Glenn Allinger 406-994-5351

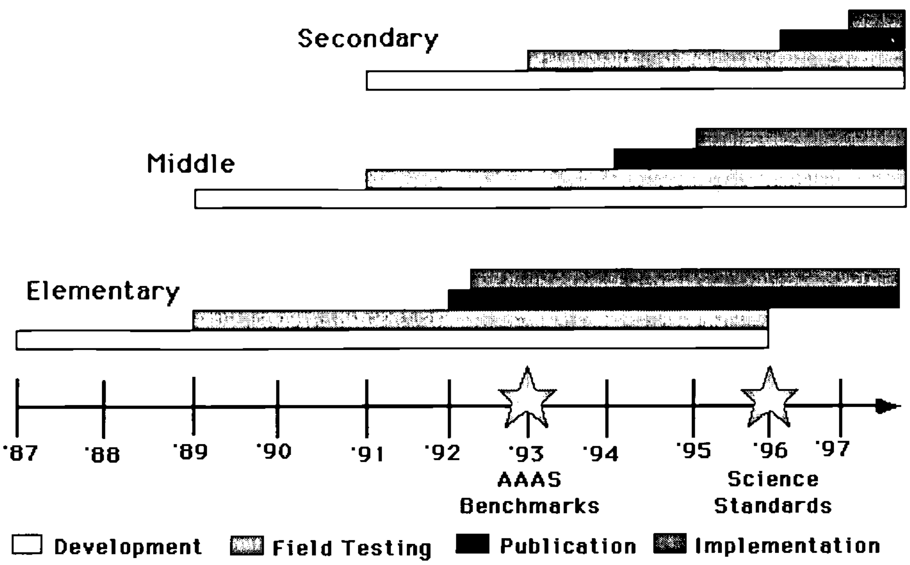
STEM: Six Through Eight Mathematics (M)
Rick Billstein 406-243-2603

TIMS: Teaching Integrated Math and Science (E)
Phil Wagreich 312-413-3019

UCSMP: University of Chicago School Mathematics Project (E, M, H)
elementary component: Max Bell 312-702-1563
secondary component: Zalman Usiskin 312-702-1560

Appendix C

Comprehensive Science Curricula



◀ back to list of Papers

NOTICE

REPRODUCTION BASIS